A STUDY OF COMBINATORIAL REASONING USING SIXTEEN BINARY OPERATIONS DURING ADOLESCENCE

DISSERTATION

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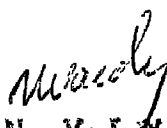
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C E R T I F I C A T E

This is to certify that Miss Abha Sharma,
student of M.Ed. of Regional College of Education, Ajmer
has conducted and completed the present dissertation
entitled " A STUDY OF COMBINATORIAL REASONING USING
SIXTEEN BINARY OPERATIONS DURING ADOLESCENCE" under
my guidance and supervision.

Her work is genuine and original.

March 7,1988   (DR. N. VAIDYA)
                                              PRINCIPAL

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Abha Sharma
(MISS ABHA SHARMA)

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CHAPTER I

BACKGROUND OF THE PROBLEM

Cognitive development is a dynamic process,
influenced by both environment and maturation. Piaget
has explained the process of cognitive development in
terms of an invariant sequence of qualitatively different
stages with each stage necessary for launching one on to
the next.

STAGES OF COGNITIVE DEVELOPMENT

Piaget's most significant contribution to
contemporary educational thought and practice has been
his characterisation of specific cognitive developmental
stages of children. Piaget has divided the periods of
cognitive development into four major developmental
stages. Each stage reflects a range of organizational
patterns which occur in a definite sequence within an
approximate age span in the continum of development.
Piaget(1953) has identified these stages as follows :

1.   The Sensory motor stage.

2.   The Pre-operational stage,

3.   The Concrete-operational stage,

4.   The Formal-operational stage.

Though pre-operational and concrete operational
stages one of great significance for educationists and
psychologists in order to understand the sequence of
cognitive development and availability of logical
structures at each stage but the present study is
related with acolescents who all are above the age of

11+ so it is imperative to elaborate the formal
operational stage.

1. SENSORY MOTOR STAGE

During this period developing organism achieves
practical knowledge, within, this period, Piaget has
identified sex sub-stages (i) The use of reflexes,
(ii) the first acquired adaptation and the primary
circular reaction, (iii) The secondary circular
reactions and the procedures dislined to make
interesting sight last, (iv) the coordination of the
secondary schemata and their application to new
situations, (v) the tertiary circular reaction and
the discovery of new means, through active experimentation
and (vi) the invention of new means through mental
combinations.

According to Piaget, simple reflexes of new
born child have become acquired adaptation as a
result of interaction with the environment.

In second substages a circular reaction refers
to the repetition of a sensory motor responses which
results are not anticipated. The third sub-stages,
is characterized by achievement of assimilation in
reproducing, reorganizing and generating assimilation.
The fourth sub-stages is a period of solidary
transform actions and marks ", the first actually
intelligent behaviour patterns. " In fifth sub-stage,
organism builds on the major achievement of the

(a) the evolution of a method for conserving new
acquisitions and transforming them into schemata.
(b) the integration of schemata in means ends relation-
ships to innate intentional grouping of behaviour.
In sixth sub-stages, organism displays the most
advanced form of goal directed behaviour and moves
towards the level of preconceptual thought.

(2) THE PRE-OPERATIONAL STAGE :

       In this stage language and symbolic thought
have their beginnings therefore this stage provides
the autogenetic origin for thought.

       Entry into this stages requires the reconstruction
which is essence amounts to translation without
contradiction,preoperational thought is the ideas of
"representation" with the related learners ability
to differentiate between them.

       Imitations i.e., the active replication of
some Model event is the product of accomodation. And
the role of assimilation in developing symbols is to
supply significante for the signifiers, which have
been drived through invitation. Perhaps, the most
limited characteristics of the preoperational thought
is its irreversibility. Piaget has splitted this stage
into two sub-stages : transductive (2-4 years) and
inductive (4-7 years).

At the sub-stage I, child fails to construct-heirarchial arrangements, because after a short while he forgets the defining properties. In sub-stage II, the child acquires a mode of dealing with many of the problems of integratin different view points and informations from different sources. Though child can get correct way of a problem but he still does not have a clear conceptual representation.

3. THE CONCRETE OPERATIONAL STAGE

The child is able to direct his attention away from the static conditions and can focus on the whole set of successive changes that occurs in the process of transformation. The starting point of concrete operations is always the real rather than potential. During this period, there are some logical inconsistencies in the child's thinking call this efficiency 'Cyncratism'.

The two fundamental types of concrete operations are : Logico-mathematical operation and spatial operation (Piaget,1967). Piaget have divided operations during this stage into two main groups logical and infra-logical. The logical operations such as establishing one to one correspondence, adding and substracting are not tied to any specific quantities, space, time or the like as are the infralogical operations (Good, 1977).

According to Flavell (1963) organism operates
with representational thought instead of direct action
on the object. The concrete operational cognitive
structure is more flexible, more consistent, more
enduring. Student has rich and integrated assimilatory
organization in equilibrium with a discriminative
accomodation mechanism. Piaget introduce non-psychological
concept of group, "lattice" and "grouping". Piaget has
identified eight grouping, which depend upon group
and lattice properties for their various characteristics.

4. THE FORMAL OPERATIONAL STAGE:

The approximate age range for one set of this
stage being 11 to 16 years, it appears to be synonymous
with the traditional stage called, Adolescence. This
is the most crucial and challenging period so, is usually
portrayed as a period of trouble and turmoil. Adolescents
are pictured as being in a stage of constant and
unrelieved conflict between the desire to remain
children and the need to assume responsibility of
adulthood. They are send to be emotionally unstable.
Piaget, in sharp contrast to traditional view, regard
this period as the most exhilarating and productive
time of life. It is the time when simple answers to
the burning question are just not good enough, Unlike,
the concrete- operationalthought which operates
on hard tangible fact only, the Formal-operational

thought is not tied up with perception and memory.

"("He) can now reason on hypothesis and not
only an objects but, he constructed new operations,
operations of propositional logic and not simply
the operations of classes, relations and m mbers.
He attains new structures, which are on the one
hand combinatorial, corresponding to what mathematicians
call lattice, on the other hand more complicated
group structure. At the level of concrete operations
the operations apply within an immediate nighbourhood.."
(Pripple and Rock Castle, 1964).

In this stage the complexity of organizing
reality has given way to the elegance of the possible,
or as Flowell says (1963) that where the concrete-
operational child deals what is the more mature
learner, using the Formal operations of intelligent
behaviour, deals with what might be.

The most distinctive features of Formal
operational thought is that the organism attempts
problem-solving with abstract considerations of
possible solutions, according to the relationships
between the elements of the problem. This type of
problem-solver will use logical analysis and combinatorial
experimentation. He sees reality as a subset of all
that is possible and has undergone a fundamental
reorientation in his approach to the problem task.

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the three major characteristics of the

developmental stage are :

(i)   a base in a hypothetico-deductive model.

(ii)   the use of propositional reasoning and finally,

(iii)   the use of combinatorial analysis.

Hypothetico-deductive reasoning means that the

learner, manipulates propositions containing the data

of reality, but he is not limited to reality, as in

concrete operator. The formal operator organizes concrete

structure by accomodation and assimilation and evolves

propositions and operates on them, thereby producing

logical and testable statements by means of "implication,

connection, conjuction and identity". Implications is

the ability to embed one thought in another, connections

means , the merging of two or more propositions,

conjuction is the linking of multiple propositions, and

identity is the presence of two, equal elements in

propositions.

...

COMBINATORIAL REASONING AND INRC

Identifying and controlling experimental variables
in a systematic way assumes an underlying combinatorial,
system. Before these combinations are random but
later systematic and complex. At formal stage the
child adopts a step by step combination method with
generalization (Gruber and Vonchh, 1977).

Combinatorial analysis is an abstract-approach
to problem-solving unique to formal operations. The
learner using combinatorial analysis for isolating
all the elements of a propositions and then recombined
them in all possible ways. This "second degree grouping
of operations". (Piaget,1950) constitutes the
structure of final equilibrium towards which concrete
operation tend. The same operational content is
involved : classing, serating, numbering and measuring.
However, although there is an essential relationship
between concrete and formal operational, there is a
vertical separation between them, that is, a different
psychological problem is evolved (Piaget,1950).

Piaget (1967) summarizes the three "novelties"
of the formal stage :

a)   There is a generalization of classification
        leading to the classification of the second degree,
        called the 'combinatorial'.

b)   This combinatorial allows the addition proposition
      operations (p,q etc.) to the operations of
      classes and relations. This implies a more general
      form of logic in which the form is independent of
      the content.

c)   This formal structure thus become completely
      reversible with N and R. There is then a complete
      group of four transformations: I=NRC. This INRC
      group is a set of four operations i.e. Identity,
      Negation, Reciprocity and correlation operation.

      Thus the organization of thought moves away from
"thing" towards "ideas" and it involves deducing
conclusion from proposition rather than facts actually
verified by the adolescents.

CRITIQUE OF PIAGET THEORY

      The work of piaget has been criticized on
different grounds by several workers. They are: montghes
(1966), Kagan (1960), Seiler (1973), Overtone and Reese
(1973), Rottentreich (1975), Totilman (1976), Harten
(1977), Tripp (1978), Pascual Leone (1980) etc. Their
criticism has been summarized by Vuyk, Rita (1981) in
her recent publication entitled "Overview and critique
of Piaget's Genetic Epistemology" 1965-1980 Academic
Press INC (London, 1981).

1. Piaget's assumption that the adolescent reflects on the combinatorial system as a whole and that such reflection facilitates effective thinking is unjustified.

2. Piaget's theory of formal operations is wrong because not all adolescents can solve the 'tests' for formal operations.

3. Adolescents are not as a good in logical reasoning as piaget claims.

4. Many young children are quite capable of syllogistic and conditional reasoning though Piaget says that they are not.

5. We haven't adequately clarified precisely what we mean by formal operations, in both the methodological and the formal definitional senses.

6. Piaget gives no clear criteria for deciding that adolescents do "work within the combinatorial system" while children are supposed to be incapable of doing so.

7. "Reasoning is radically affected by content in a systematic way; and this is incompatible with the Piagetian view that in formal operational thought the content of a problem has at last been subordinated to the form of relations in it".

8.   Piaget makes number of blunders due to his lack
      of knowledge of elementary mathematics and
      physics.

9.   He never accepts falsifications of his experimental
      results of his critics.

10.   His experiments look very simple but are infact,
      too complex for a detailed analysis.

11.   Piaget is wrong in claiming that philosophy does
      not give us truth but that science does.

12.   He does not know of recent development in
      cognitive psychology, information processing,
      psychology of thinking etc.

      Piaget provided rich model of investigating not
only for learning but also for teaching. His ideas
are still at the conjectural stage which is under
scruting all over the English speaking world.

JUSTIFICATION OF THE PROBLEM

      Much of the research work has been done on
adolescence stage. Adolescence is a very important
period as suggested by Prof. Jean Piaget. At
adolescence, individual mind becomes truly experimental,
because he makes hypothesis and test them by
experimentation. Due to its anemolous nature, but most
of the studies of this stage were related to social
life longitudinal research on this stage helps us to

appreciate. The importance of adolescence in the total
life how it builds on childhood experience and
constitutes a transition to the future (Anderson,1979)
while cross cultural cross sectional studies compares
the cultures and different aspects of development.
Most of the studies concentrated only on the
determinations of various stages of development
(concrete, post concrete and formal) on which child
operates. While other studies also have tried to
find out the relationship of each stages of thought
with different variables like personality linguistic
abilities. In this study only one scheme of thought
has take fifteen plus one items based on Piaget type
items to measures the combinatorial reasoning,
adolescent thoughts and its relates with academic
achievement.

STATEMENT OF THE PROBLEM

The purpose of this study is to investigate
growth of logical thinking and its relationship with
Academic Achievement. In precise the purpose of study
may be stated as :

   " A STUDY OF COMBINATORIAL REASONING USING

   SIXTEEN BINARY OPERATIONS DURING ADOLESCENCE".

PRESENT STUDY AT A GLANCE

The present study has been described in six chapters excluding appendix and bibliography.

The first chapter deals with the background of the Piagetian thinking and problem solving ability. The second chapter deals with the related research studies and the summary of findings of those studies. The distinct features of the present study in the light of the various related literature are also presented in the same chapter. The plan and procedure of the study are discussed in the third chapter. It deals with the selection of the sample, data gathering instruments, their administration, scoring objective and hypotheses etc. The responses on the tests and their analysis are presented in the chapter fourth. The mean, and SD for the various tests used, are presented in the same chapter. The results of statistical analysis, discussions and conclusions are presented in the chapter fifth. The chapter sixth deals with the summary of the study, educational implications, problems for the further research etc.

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CHAPTER II

REVIEW OF THE RELATED LITERATURE

C H A P T E R   II

REVIEW OF THE RELATED LITERATURE.

INTRODUCTION

The Review of the literature is critical aspect
of the planning of the study. So the research for
reference material is fruitful phase of the research
programme. It provides a depth understanding of the
type of research work going on in the field, and it
also provides one with means of getting to the frontier
in a particular field of knowledge.

Adolescence is a period of affliction, uneasiness,
distress, turmoil, and agitation on the one hand
productive, interesting, and exhilarating instances
on the other hand. At this stage a child matures
physically, physiologically, psychologically and
socially. According to Rogers (1981), "adolescence
is a process rather than a time period, a process of
achieving the attitudes and beliefs in society". It

may be interpreted in another ways as well as a period
of physical development, as a socio cultural phenomena,
or even abstractly as an attitude towards life.
Defined chronologically, or in terms of calender years,
adolescence embraces the period 12 or 15 years of age
until 18 or 22. adolescence is often viewed as a
transition, a link between childhood and adulthood
with no genuine essence of its own.

Survey of the related literature is necessary
for scientific approach as well as for theoritical and
experimental work. It also develops an insight into
the problem to be investigated. It is necessary to
know about the researches which have been done and
which remains to be done in that particular field.
'Bost' states that, "To know that source to use, what
source are available and where and how to find them
will have many houses of aimless activity".

Much of the research work has been done on
Adolescent stage due to its anamolous nature. Adolescence,
research has its special methodologies and deficiencies.

Longitudinal research on the stage help us to
appreciate the importance of adolescence in the total
life how it builds on childhood experience and
constitutes a transition to the future (Anderson, 1979)
while other research studies have been concentrated

only on the determination of the various stages of
development (concrete, post-concrete and formal)
on which a child operates. Very few studies tried to
analyse the various dimensions of adolescent thought
with its mathematical structure. In this study sixteen
binary operations based on combinatorial reasoning
are taken to measure the dimensions of adolescent
thought.

The present study has been restricted to the area
of combinatorial reasoning and its relationship with
achievement. The area wise related studies are given
below.

JUSTIFICATION WITH REVIEWED LITERATURE

The researcher has tried to scan out the needed
studies in the aforesaid areas and during his hunt
for related literature, it was observed that the
studies in particular area have been given citation in
combinations of different variables, in different grounds
of repuleforeign as well as Indians. The researcher
has tried his best to complete the necessary studies
as related to this project, but these should be viewed
as whole, "not in different directions".

SOME RELATED STUDIES

Vaidya (1964) investigated problem solving in science among certain groups of adolescent pupils(15[+]) using questionnaire approach (N=60) as well as interview approach (N=31), found that adolescent pupils do not hestiate to criticisze data. Secondly, there is a general tendency among adolescent pupils to set up hypotheses which they test against tho given data. Thirdly, a poor problem solver appears to stick to one data as a time, stubbornly and, later on, ceases to think of alternative idea. He also observed that adolescent pupils solve science problem over a wide I.Q. range.

Lawson, Nordland and Devito (1974) analysed response on five Piagetian formal operational tasks in a test-retest method to determine tho extent to which taking pre-test affected scores on post-tests. Seventeen college freshmen and nineteen college sophomers enrolled in course, and elementary school teachers served as a subject (34 females and 2 males) ranged in age from 17.5 to 20.0 years with the median age 18.5 years. The five tasks : Conservation of volume and metal cylinder tasks, Exclusion of variables, Separation of variables and Equilibrium in the balance were taken with pre-test and post-test interviews. The significant gains made on the two conservation of volume obviously do not indicate cognitive. Although

direct physical experience is necessary for cognitive growth. Test-retest tasks reliabilities ranged widely.

Lawson (1975) in study of 'Sex differences in concrete and formal reasoning ability as measured by manipulative tasks and written tasks'. A sample of 62 high school students (31 males and 31 females) were randomly selected for this study. Results showed that males performed significantly better than females on manipulative tasks, but the differences between the males and females on written tasks were less than the former. Both written and manipulative measured different parameters.

Shayer and Wylam (1978) in the Distribution of Piagetian stages of Thinking in British Middle and Secondary School Children of 14 to 16 years old, found the girls' performance substantially low on the test on relationships on volume and density.

Vaidya (1979) studied 'The Growth of Logical Thinking in Science during Adolescence" on a sample of 100 boys and 100 girls, studying in grade VI to X matched on intelligence and socio-economic status. The main findings of this study are:

1.   Except for occasional fluctuations, average
     performance on each problem increases with age.

2.   Mean performance is most of the cases favour
     boys rather than girls, however, they try hard
     to equalise their performance as they move into
     higher grades.

3.   A given problem is solved successfully (or failed)
     over a wide I.... range both within and across
     the various grades.

4.   The complex problem solving processes arise from
     simple thinking processes.

5.   The adolescent pupils are affected by the content
     of the problem than the nature of the problem
     (contrary to Piaget's view).

6.   Adolescent pupils are in a position to set up
     hypotheses, but they are not in a position,
     contrary to Piaget to test them. This shows
     that their minds have not yet become experimental.

7.   The top group differed from the bottom group on
     all the five measures of adjustment, understanding
     of the problem and all the seventeen schemes of
     thought.

Blake, Lawson and Nordland (1979) in the
'Karplus Islands Puzzle' manipulative as well as written
tasks were used. Results showed that higher inter-
correlations among the Islands puzzle questions than
among the three Piagetian tasks. This showed that the
three Islands puzzle questions shown acceptable internal
consistency while the significant correlations among
Islands puzzle measures and Piagetian measures are
indication of moderate relationship.

Walker, Hendix and Mistens (1979) conducted a
study on 'Written Piagetian Task Instrument' using
six tasks based on proportional reasoning, combinations
and hypodeductive logic was administered 96 students
at the age of 15 years. Pre-test results indicated
that 62 were at formal level and 24 were either at
concrete or post concrete level. Following a three
weeks interval post-test indicated 19% increase in
the number of formal level students.

Lawson and Shephered (1979) in 'Syntactical
Complexity' in written language and cognitive development
at formal level, found that cognitive maturity
especially the development of formal reasoning is
related to written language maturity.

Raizada (1979) in her study of relationship
between problem solving ability and some relative
personality traits using Piagetian type tasks found

the significant correlations between the grades and scores
of all types of Piagetian tasks except those relating
to classification and grouping of thought. She also
observed that intelligence correlated significantly
with all the types of Piagetian tasks. Girls exceeded
boys on all tasks except on ratio and proportion.

Blake (1980) investigated the predictive power
of science test and written Piagetian test and also
observed the relationship between these two. The results
showed that the strength of relationship between
performance on understanding in science test and
performance on the tasks was reduced only by the
influence of reading ability in younger students.
Understanding in science test is a better predictor of
Piagetian level and development in higher grades
than in younger.

Sandhu (1980) in a doctoral study, on the
"Factorial study of Adolescent Thought" investigated
the thinking processes of adolescents (N=986) of rural
area between the age group 11+ to 15+ using 10 Piaget
type written tasks with 24 other variables and found:

1.   The performance on Piaget type tasks increases
      with age during the formal operational period and
      boys fair better than girls at the respective
      age levels.

2. Intelligence and academic achievement have
    direct bearing on adolescent thought.

3. The development of formal thinking leads to
    better adjustment of the individual and vice-versa.

4. Eight significant factors were extracted through
    factor analysis of the data. These factors had
    accounted for 49% of the total variance operating
    among all the 34 variables taken for the study.
    The factors extracted were named as 'General
    intellectual factor, Academic achievement,
    Adjustment, Behavioural factor, Emotional factor,
    Temperamental factor, Group factor of adolescent
    thought and Social factor.

Mathur (1981) investigated the 'Growth of
Experimental Mind During Adolescence' on a sample of
120 pupils studying in grade VI to XI ranging in age
between 11+ to 16+, she found that the performance on
Piaget type tasks show an increasing trend in grade
with occasional fluctuations on certain tasks. It was
found that the capacity to grasp the essence of the
problem increased with grade.

Padmini (1982) studied the Growth of Exclusion
of Variables During Adolescence and found that the
mean performance on stating of hypotheses increases with
grade and indirectly with chronological age. She
observed sex differences with occasional fluctuations

exist, favouring girls. Majority of the adolescent
pupils were attracted more by the content rather than
the form of the problem in her study. Four factors
were extracted through factor analysis of the data,
namely: Stating of hypotheses, testing of hypotheses,
permutations and combinations, and problem sensitivity.

Mathur (1983) in a study of Logical Thinking
Among certain Groups of Adolescents on a sample of
160 pupils studying in grades VI to X ranging in
between 11[+] to 15[+] respectively. She found the increase
in the performance of Piaget type tasks and I.Q.
with grades. No significant sex difference was
observed except in X grade on thinking process and
I.Q. in her study.

Sadhna (1984) in a study of adolescent thought,
observed the increase in the performance on Piaget type
tasks with age in adolescent pupils and the found
significant intercorrelations between all seven
schemes of thought of adolescents. Two significant factor
were extracted, namely : Stating of hypotheses and
I.Q. in her study.

CONCLUSIONS OF THE FINDINGS

From the various research studies, which are directly or indirectly related with this problem presented on the preceding pages of the review, the following tentative statements can safely be made.

1. The concrete-operational stage is quite dominant among normal adolescent pupils. Most of the children even upto the age of 20 years do not reach to the formal stage.

2. Adolescent's success on problems increases with chronological age and grade.

3. Most of the students studies showed no sex differences in the development of formal thought, but few observed the domination of females in urban areas, and of male in rural areas.

4. Significant relationships are found to exists between sixteen binary operations.

5. The beginning of formal thought is at possibly 13 or 14 years of age.

6. The significant relationship of academic achievements in Science subjects with level of intellectual development observed.

7. Majority of the adolescent pupils are attracted by content rather than the type of the problem.

8. There is possibility of a fifth stage called

problem finding stage beyond 16$^+$ years.

DISTINCT FEATURES OF THE PRESENT STUDY

The distinct features of the present study are enlisted below :?

1. It attempts to study the combinatorial reasoning using sixteen binary operations during adolescence.

2. The sample has been drawn randomly, from among equal numbers of boys and girls.

3. A number of outside variables have been included with a view to investigate the phenomena in depth.

4. The sixteen binary operations included in this study has a continuous chain of reasoning and thinking.

5. This study is conducted in urban area of Ajmer city.

6. It attempts to study the relationship between combinatorial reasoning of sixteen binary operations during adolescence and achievement.

* * *

CHAPTER III

PLAN AND PROCEDURE OF THE STUDY

C H A P T E R   III

PLAN AND PROCEDURE OF THE STUDY

INTRODUCTION

In order to make the present study yield fruitful

results, the investigator consulted all the available

literature, given in Chapter II. A familarity with

literature in any problem area helps the students to

discover what is already known, what others have promising

or disappointing and what problems remain to be solved.

The decision about the method to be employed

depends upon the nature of the problem and the kinds

of data necessary for its analysis and solution. The

success of any research is dependent upon the selection

of appropriate method and the tools for study of the

problem. The method selected, the tools and statistics

employed for the problem under investigation have been

dealt systematically in the chapter.

Plan and procedure of the study was framed on
the basis of available relevant literature and the
psychological theories.The selection of the sample, objective:
hypotheses, data gathering instruments, methods of
administration, statistical treatment of data and
scoring of the tests etc. are described in this chapter.

The basic idea of this study is to see the effect
of sex on sixteen binary operations and on achievement in
different subjects like English,Hindi, Maths, Science
and Social Science. This study included 24 variables.
The variables with their code are given below :

Table 1

(Twenty four variables with their codes)

S.No. of Variables	Name of variables	Code
1.	Sex (Boys) (Girls)	S(B) (G)
2.	Achievement	Ac
3.	Achievement in English	E
4.	Achievement in Hindi	H
5.	Achievement in Maths	M
6.	Achievement in Science	S
7.	Achievement in Social Science	SS
8.	Raju and I robbed the bank together	I_1
9.	I robbed the bank on my own	I_2
10.	I am certain Raju did not rob the bank	I_3

S.No. of Variables	Name of variables	Code
11.	I robbed the bank but I am not saying whether Raju robbed the bank with me	I_4
12	At least one of us robbed the bank	I_5
13	I certainly did not rob the bank	I_6
14	I am sure that Raju robbed the bank	I_7
15	We could not have robbed the bank together	I_8
16.	Neither of us robbed the bank	I_9
17.	Only one of us robbed the bank	I_{10}
18.	Raju robbed the bank of his own	I_{11}
19.	If we did rob the bank, we did it together	I_{12}
20.	If Raju did not rob the bank, I robbed it	I_{13}
21.	If I robbed the bank, Raju robbed the bank	I_{14}
22	If I did not rob the bank, Raju did not rob it.	I_{15}
23.	If I did rob the bank, Raju did not rob it.	I_{16}
24	Total Adolescent thought	I_T

OBJECTIVES OF THE STUDY

The objectives of the present study are as follows :

(1)   To investigate the effect of sex on the performance of fifteen binary operations, achievement in different subjects and total adolescent thought.

(2)   To determine the effect of sex on Hindi, English,
        Science, Maths and Social science and total
        achievement.

(3)   To point out the main educational implications
        arising out of the present study.

(4)   To find out the relationship between combinatorial
        reasoning (logical thinking) and achievement
        in English, Hindi, Maths, Science and Social
        Science.

HYPOTHESIS

(1)   There is no sex-wise significant difference on
        the scores of fiteen binary operations and
        total adolescent thought, as well as for the
        combined groups.

(2)   There is no significant co-rrelation between
        fifteen binary operations and total achievement
        in English, Hindi, Maths, Science and Social
        Science of total sample.

(3)   There is a hierarchy among the fifteen binary
        operations of propositional logic such that
        certain operations are prerequisite to subsequent
        operations.

DELIMITATIONS OF THE STUDY

        Due to paucity of time and resources, the present
study was delimited with regard to area, method and
sample, the delimitations are as follows :

(1) The study was limited only total sample of 200 students (100 boys and 100 girls) drawn randomly from English medium Higher Secondary schools.

(2) The study was confined to English medium school of Ajmer city.
   (i) Mayo College (Boys)
   (ii) St.Anselm's Hr.Sec.School (Boys)
   (iii) Sophia Girls Hr.Sec.School (Girls)
   (iv) St.Mary's Hr.Sec.school (Girls)
   (v) DMS (Boys and Girls)

(3) In all, the 25 girls and 25 boys were taken from each age levels.

(4) The present study was limited to the 16 binary operations (I_1 i.e. first operation is taken as an example) which are based on Combinatorial reasoning (logical thinking).

(5) As regards the statistical treatment of data, the mean, SD, t- test and correlation were computed.

(6) The data on 24 variables relating to this study were obtained.

CRITERIA FOR SELECTION OF THE INSTITUTION AND SAMPLE

The first step was selection of the institution, while selecting the institutions, the researcher

adopted the following criteria:

(1)   Higher-Secondary schools having English medium
        of Ajmer City were selected for the present study,
        for the sake of convenience.

(2)   The following institutions of Ajmer city were
        selected randomly for the present study-

        (i) Mayo College, Ajmer

        (ii) St.Anselmn's Hr.Sec.school, Ajmer

        (iii) Sophia Girls Hr.Sec.school, Ajmer

        (iv) St.Mary's Hr.Sec.school, Ajmer

        (v) D.A.S., Ajmer.

SAMPLE

Initially a sample of 300 students was drawn
randomly from five English Medium schools taking 150
boys and 150 girls, respectively studying in class XI.

The final sample was drawn comprised 200 students
(100 boys and 100 girls), who appeared in the tests.
Frame of the final sample is as given below:

Sample

N=200

XI Class Pupils

```
                    ┌──────────────┴──────────────┐
                100 Boys                      100 Girls
        ┌──────────┼──────────────┐              │
    Mayo        St.Anselm's      D.M.S.          │
    College     Hr.Sec.          Ajmer           │
    Ajmer       School,                          │
    (N=35)      Ajmer            (N=25)           │
                (N=40)                            │
                                                  │
        ┌─────────────────────────┼──────────────────────┐
    Sophia Girls              St.Mary's              D.M.S.
    Hr.Sec.                   Hr.Sec.                Ajmer
    School,Ajmer              School,                (N=10)
    (N=45)                    Ajmer
                              (N=45)
```
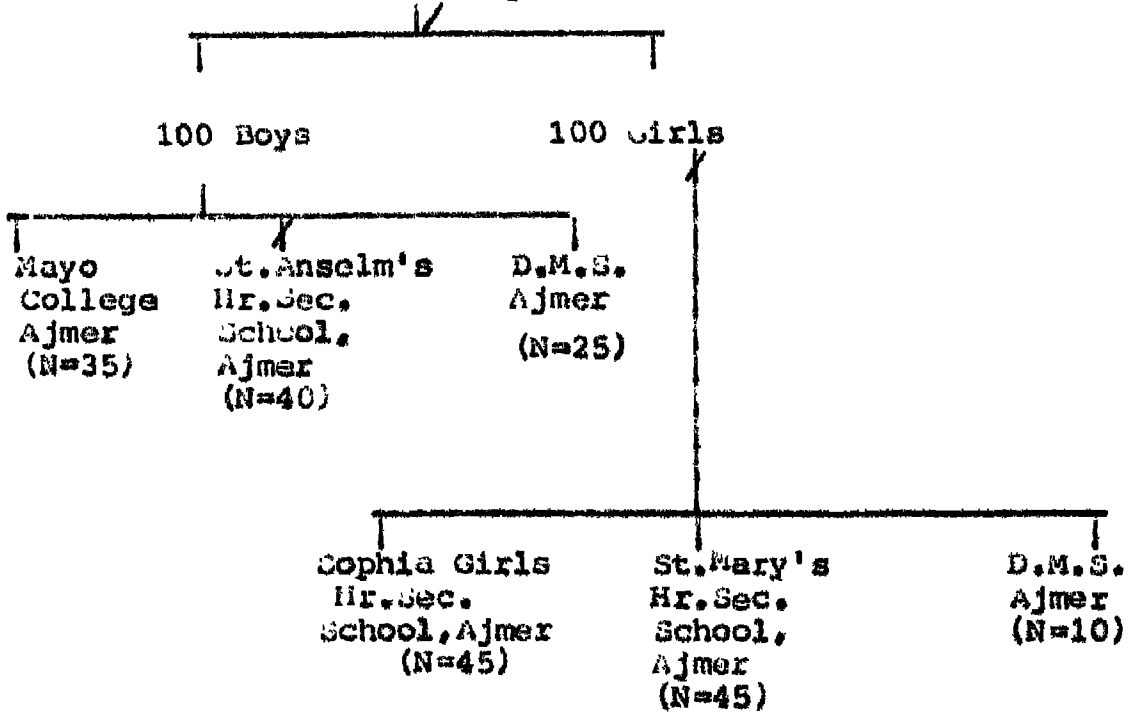
BINARY OPERATIONS OF INTERPROPOSITIONAL LOGIC

Organisation of thought to include possibilities relies upon a hypothetico-deductive structure requiring a more advanced form of syllogestic reasoning. Both concrete and Formal operations may be characterized in terms of logico-mathematical structures of inter-propositional operations. The Concrete Operational child is able to observe and identify a number of associations between objects and the occurence or non-occurence of these same objects or events. Confined to interpreting empirical data, he may classify four associations. In the situation where p represents a proposition, p̄ its

negative, q another proposition, and q its negative,
the concrete operational child is able to form four
multiplicative grouping (1) p,q (2) p,q̄ (3) p̄,q, and
(4) p̄,q̄. These statements of occurence and non-occurence
represent the following :

(1)   p,q, situation A occurs with B present;

(2)   p,q̄, situation A occurs with B absent;

(3)   p̄,q, situation A need not always occur with B
        present; and

(4)   p̄,q̄, situation A may also not occur when B is
        absent.

        Adolescent or Formal Operational reasoning extends
beyond these four multiplicative groupings through the
inclusion of hypothetical assertions involving
combinatorial operations. Allowing the letters a,b,c
and d to represent the four original associations,
sixteen possible combinations emerge (Table 2)

Table -2

Piagetian Lattice or the Sixteen Binary Propositions

1.	a	i.e., (p.q)
2.	b	i.e., (p.q̄)
3.	c	i.e., (p̄.q)
4.d	d	i.e., (p̄.q̄)
5	a+b	i.e., (p.q) v (p.q̄)
6.	a+c	i.e., (p.q) v (p̄.q)

7.   a+d   i.e., $(p.q)$ v $(\bar{p}.\bar{q})$

8.   b+c   i.e., $(p.\bar{q})$ v $(\bar{p}.q)$

9.   b+d   i.e., $(p.\bar{q})$ v $(\bar{p}.\bar{q})$

10.   c+d   i.e., $(\bar{p}.q)$ v $(\bar{p}.\bar{q})$

11.   a+b+c   i.e. $(p.q)$ v $(p.\bar{q})$ v $(\bar{p}.q)$

12.   a+b+d   i.e., $(p.q)$ v $(p.\bar{q})$ v $(\bar{p}.q)$

13.   a+c+d   i.e., $(p.q)$ v $(\bar{p}.q)$ v $(\bar{p}.\bar{q})$

14.   b+c+d   i.e., $(p.\bar{q})$ v $(\bar{p}.q)$ v $(\bar{p}.\bar{q})$

15.   a+b+c+d   i.e., $(p.q)$ v $(p.\bar{q})$ v $(p.q)$ v $(\bar{p}.\bar{q})$

16.   o   i.e., $(p.q)$ v $(p.\bar{q})$ v $(\bar{p}.q)$ v $(\bar{p}.\bar{q})$

DECENTRATION AND RECIPROCITY

The combinatorial system of the propositional
relations and the reversibilities of the INRC Grouping
constitute the structure of formal operational thought.
This integration of cognitive skills reaches its
equilibrium at about age 15. By this time the adolescent
has superimposed propositional logic onto the logic
of concrete classifications and has incorporated a
number of operational schemata, the INRC transformations.

The outstanding characteristic of the pre-formal
Operational child is the tendency to center, that is,
to focus upon a single feature of an object or event
to the exclusion of other significant factors. Confined
to this phenomenal interpretation of reality, the child
is given to subjective distortions of reasoning.

Table 3

Interpropositional Operations As a Group (INRC)

1. Identity (I)   This 'null' transformation changes
                     nothing in the proposition on which
                     it is performed.

2. Negation (N)   This transformation changes everything
                     in the proposition on which it bears.
                     That is, all assertions become negations,
                     and all conjuctions become disjunctions,
                     and vice versa.

3. Reciprocal (R)   This transformation permittes assertions
                     and negations but levels conjuctions
                     and dis junctions unchanged.

4. Correlative (C)   This transformation permutes conjuctions
                     and disjunctions but leaves assertions
                     and negations unchanged.

ACADEMIC ACHIEVEMENT

The term academic achievement is synonymous
of scholastic achievement. In the present study
scholastic achievement is the scores obtained by the
students in their final examination of previous year.

The marks obtained by the students in their
final examination of previous year were taken from
their school record, as the measure of their scholastic

achievement or academic achievement.

ADMINISTRATION AND SCORING OF THE TEST

This test was administered in a group of students at a time in each class. It took about 30 minutes in completing the test. First the students were explained the procedure of answering the problems using item first (I_1) as an example. The students were asked to write the answer of each item in the space provided below each item. Each item has minimum score zero and maximum score one. Partially correct answers were considered as wrong answers and scored zero.

Table 4

Weightage for the items

Item No.	Statement	Marks for each correct item
I_1	Raju and I robbed the bank together	Taken as an example
I_2	I robbed the bank on my own	1
I_3	I am certain Raju did not rob the bank	1
I_4	I robbed the bank but I am not saying whether Raju robbed the bank with me	1
I_5	At least one of us robbed the bank	1
I_6	I certainly did not rob the bank	1
I_7	I am sure that Raju robbed the bank	1
I_8	We could not have robbed the bank together	1

Item No.	Statement	Marks for each item
I_9	Neither of us robbed the bank	1
I_{10}	Only one of us robbed the bank	1
I_{11}	Raju robbed the bank of his own	1
I_{12}	If we did rob the bank, we did it together	1
I_{13}	If Raju did not rob the bank, I robbed it	1
I_{14}	If I robbed the bank; Raju robbed the bank	1
I_{15}	If I did not rob the bank, Raju did not rob it	1
I_{16}	If I did rob the bank, Raju did not rob it	1
Total weightage for all items		15

STATISTICAL TECHNIQUES USED

The statistical techniques used in the analysis of the data are given below :

(i)   Descriptive statistics like mean and standard deviation were calculated.

(ii)   The 't' test was employed to find out the significance of difference between means related to different sub groups of the variables.

(iii)   Scatter-diagram, method of correlation was used for determining the relationship among the variables.

TABLE 5

Scores of Grade XI Science-Boys and Girls in decending order.

S. No.	Sex	I 16	I 5	I 8	I 14	I 12	I 10	I 13	I 6	I 15	I 4	I 3	I 11	I 7	I 9	I 2	Total
1	B	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	05
2.	G	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	04
2	B	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	05
	G	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	04
3	B	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	05
	G	0	0	0	0	0	0	0	1	0	0	1	1	0	1	1	05
4	B	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	05
	G	0	0	0	0	0	0	0	1	0	0	1	1	0	1	1	05
5	B	0	0	0	0	0	0	0	1	0	1	1	1	0	1	1	06
	G	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	05
6.	B	0	0	0	0	0	0	0	1	0	1	1	0	1	1	1	06
	G	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	05
7.	B	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	06
	G	0	0	0	0	1	0	0	0	1	0	0	1	1	1	1	05
8	B	0	0	0	1	0	0	0	0	0	1	1	1	0	1	1	06
	G	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	05
9	B	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	06
	G	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	05
10	B	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	06
	G	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	06
11	B	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	06
	G	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	06
12	B	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	07
	G	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	06

S. No.	Sex	I 16	I 5	I 8	I 14	I 12	I 10	I 13	I 6	I 15	I 4	I 3	I 11	I 7	I 9	I 2	Total
								Fifteen Binary Operations									
13	B	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	07
	G	0	0	0	0	0	1	0	1	0	1	1	1	0	0	1	06
14	B	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	07
	G	0	0	0	0	0	0	0	1	0	0	1	1	1	1	1	06
15	B	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	07
	G	0	0	0	0	1	1	0	0	0	1	1	0	1	0	1	06
16	B	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	07
	G	0	0	0	0	1	1	0	0	0	1	1	0	0	1	1	06
17	B	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	07
	G	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	06
18	B	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	07
	G	0	0	0	0	0	0	0	1	1	0	0	1	1	1	1	06
19	B	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	07
	G	0	0	0	0	0	0	0	1	1	0	0	1	1	1	1	06
20	B	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	08
	G	0	0	1	0	0	0	0	1	1	0	0	1	0	1	1	06
21	B	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	07
	G	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	06
22	B	0	0	0	0	0	0	0	0	1	.	1	1	1	1	1	07
	G	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	06
23	B	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	07
	G	1	0	0	0	0	0	1	1	1	0	0	1	1	0	1	07
24	B	0	0	0	0	0	0	1	1	0	1	1	1	1	1	1	08
	G	0	0	0	0	1	0	0	1	0	1	1	0	1	1	1	07

No.	Sex	Fifteen Binary Operations															Total
		I 16	I 5	I 8	I 14	I 12	I 10	I 13	I 6	I 15	I 4	I 3	I 11	I 7	I 9	I 2	
25	B	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	08
	G	0	0	0	0	0	1	0	0	1	0	1	1	1	1	1	07
26	B	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	08
	C	0	0	0	0	0	1	0	0	1	0	1	1	1	1	1	07
27	B	0	0	0	0	0	0	1	1	0	1	1	1	1	1	1	08
	G	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	07
28	B	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	08
	G	0	0	0	0	0	0	0	1	1	0	1	1	1	1	1	07
29	B	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	08
	G	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	07
30	B	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	08
	G	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	07
31	B	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	08
	C	0	0	0	0	1	0	0	0	1	1	0	1	1	1	1	07
32	B	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	08
	G	1	0	0	0	0	1	0	0	1	1	1	0	0	1	1	07
33	B	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	08
	G	0	0	0	0	1	0	0	1	0	1	1	1	1	1	1	08
34	B	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	08
	G	0	0	0	1	0	1	0	1	0	0	1	1	1	1	1	08
35	B	0	0	1	0	0	0	1	1	0	1	1	1	0	1	1	08
	G	0	0	0	0	0	1	0	0	1	1	1	1	1	1	1	08
36	B	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	08
	G	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	08

S. No.	Sex	Fifteen Binary Operations															Total
		I 16	I 5	I 8	I 14	I 12	I 10	I 13	I 6	I 15	I 4	I 3	I 11	I 7	I 9	I 2	
37	B	0	0	0	1	0	1	1	1	0	1	1	1	1	0	1	09
	G	0	0	0	0	0	1	0	1	1	0	1	1	1	1	1	08
38	B	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	09
	G	1	0	0	0	1	1	0	1	0	1	1	0	1	0	1	08
39	B	1	0	1	1	0	0	1	1	1	1	0	0	0	1	1	09
	G	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	08
40	B	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	09
	G	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	08
41	B	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	08
	G	0	0	0	1	0	0	1	1	1	0	1	1	1	0	1	08
42	B	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	10
	G	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	08
43	B	1	0	0	1	0	0	1	0	1	0	1	1	1	1	1	09
	G	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	08
44	B	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	09
	G	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	08
45	B	0	0	0	0		0	0	1	1	1	1	1	1	1	1	09
	G	0	0	1	0	0	0	0	1	1	0	1	1	1	1	1	08
46	B	1	0	0	0	1	0	0	0	1	1	1	1	1	1	1	09
	G	0	0	0	1	1	0	0	1	1	1	1	0	1	1	0	08
47	B	0	0	0	0	0	1	1	1	0	1	1	1	1	1	1	09
	G	0	0	0	0	1	1	0	0	1	1	1	1	1	0	1	08
48	B	1	0	0	1	0	1	1	1	1	0	0	0	1	1	1	09
	G	0	0	0	0	0	1	1	0	0	1	1	1	1	1	1	08

S. No.	Sex	Fifteen Binary Operations															Total
		I 16	I 5	I 8	I 14	I 12	I 10	I 13	I 6	I 15	I 4	I 3	I 11	I 7	I 9	I 2	
49	B	0	0	1	0	0	0	1	0	1	1	1	1	1	1	1	09
	G	0	0	0	0	0	1	0	0	1	1	1	1	1	1	1	08
50	B	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	09
	G	0	0	0	0	1	0	0	1	1	1	0	1	1	1	1	08
51	B	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	09
	G	0	0	0	0	0	0	1	1	1	1	0	1	1	1	1	08
52	B	0	0	1	0	1	0	1	1	1	0	1	0	1	1	1	09
	G	0	0	0	0	0	1	0	1	1	0	1	1	1	0	1	08
53	B	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	09
	G	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	09
54	B	0	0	1	0	1	0	1	1	1	0	1	1	0	1	1	09
	G	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1	09
55	B	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	09
	G	1	1	0	0	0	0	0	1	0	1	1	1	1	1	1	09
56	B	0	0	0	1	1	1	1	0	0	1	1	1	0	1	1	09
	G	0	1	0	0	0	0	1	1	0	1	1	1	1	1	1	09
5/	B	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10
	G	0	0	0	0	1	1	0	0	1	1	1	1	1	1	1	09
58	B	0	0	0	1	1	1	1	1	1	1	0	0	1	1	1	10
	G	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	09
59	B	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	10
	G	0	0	0	0	1	1	0	1	0	1	1	1	1	1	1	09
60	B	0	0	0	1	1	0	1	1	1	1	1	0	1	1	1	10
	G	0	0	1	0	1	0	1	1	0	1	1	1	0	1	1	09

S. No.	Sex	I 16	I 5	I 8	I 14	I 12	I 10	I 13	I 6	I 15	I 4	I 3	I 11	I 7	I 9	I 2	Total
61	B	0	0	0	0	1	1	1	0	1	1	1	1	1	1	1	10
	G	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	09
62	B	0	1	0	0	1	1	1	1	1	0	1	1	0	1	1	10
	G	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	09
63	B	0	0	0	0	0		1	1	1	1	1	1	1	1	1	10
	G	0	0	0		0	1	0	0	1	1	1	1	1	1	1	09
64	B	0	0	1	1	0	1	1	1	1	0	1	1	1	0	1	10
	G	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	09
65	B	0	0	1	0	1	1	0	0	1	1	1	1	1	1	1	10
	G	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	09
66	B	0	0	0	1	1	1	0	0	1	1	1	1	1	1	1	10
	G	1	0	0	0	1	0	0	0	1	1	0	1	1	1	1	09
67	B	1	0	0	0	1	1	1	1	1	0	1	0	1	1	1	10
	G	0	1	0	0	0	0	0	1	1	1	1	1	1	1	1	09
68	B	1	0	0	0	0	1	0	1	1	1	1	1	1	1	1	10
	G	0	1	1	0	1	0	0	0	1	0	1	1	1	1	1	09
69	B	0	0	1	1	1	0	1	1	1	1	0	1	1	0	1	10
	G	0	1	1	0	1	1	0	0	1	1	0	0	1	1	1	09
70	B	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10
	G	0	0	1	0	1	0	0	1	1	1	1	1	1	1	1	10
71	B	0	1	0	1	0	1	1	0	1	1	0	1	1	1	1	10
	G	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10
72	B	0	0	0	1	0	1	0	1	1	1	1	1	1	1	1	10
	G	0	1	0	1	0	1	0	1	1	1	1	1	1	0	1	10

S. No.	Sex	Fifteen Binary Operations															Total
		I16	I5	I8	I14	I12	I10	I1J	I6	I15	I4	I3	I11	I7	I9	I2	
73	B	0	0	1	1	0	1	1	1	0	1	1	0	1	1	1	10
	G	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	10
74	B	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10
	G	0	1	0	1	0	1	0	1	1	0	1	1	1	1	1	10
75	B	0	0	1	1	1	1	1	1	0	1	1	0	1	1	1	11
	G	0	0	0	1	1	1	0	1	1	1	1	0		1 1	1	10
76	B	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	11
	G	0	1	1	1	0	1	1	0	1	1	0	1	1	0	1	10
77	B	0	0	1	1	0	1	1	1	0	1	1	1	1	1	1	11
	G	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	10
78	B	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	11
	G	0	0	0	0	1	0	1	1	1	1	1	1	1	1	1	10
79	B	0	0	0	1	0	1	1	1	0	1	1	1	1	1	1	11
	G	0	0	1	0	0	0	1	1	1	1	1	1	1	1	1	10
80	B	0	1	0	0	1	0	1	0	1	1	1	1	1	1	1	11
	G	0	0	1	0	1	0	0	1	1	1	1	1	1	1	1	10
81	B	0	0	1	0	1	0	1	1	1	1	1	1	1	1	1	11
	G	0	1	0	0	1	1	0	0	1	1	1	1	1	1	1	10
82	B	0	1	1	1	0	0	1	0	1	1	1	1	1	1	1	11
	G	1	0	0	0	1	0	0	1	1	1	1	1	1	1	1	10
83	B	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	11
	G	0	1	1	1	1	0	1	1	1	0	0	1	1	1		11
84	B	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	11
	G	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	11

S. No.	Sex	I 16	I 5	I 8	I 14	I 12	I 10	I 13	I 6	I 15	I 4	I 3	I 11	I 7	I 9	I 2	Total
85	B	0	0	1	0	1	0	1	1	1	1	1	1	1	1	1	11
	G	0	0	1	1	1	1	0	1	1	1	1	1	1	0	1	11
86	B	0	0	1	0	0	1	1	1	1	1	1	1	1	1	1	11
	G	0	0	1	0	1	0	1	1	1	1	1	1	1	1	1	11
87	B	0	1	1	1	1	0	1	0	1	1	1	1	1	1	1	12
	G	0	0	1	1	1	0	0	1	1	1	1	1	1	1	1	11
88	B	1	1	0	1	1	0	0	1	1	1	1	1	1	1	1	12
	G	1	1	1	1	0	1	0	1	0	1	1	1	1	0	1	11
89	B	1	1	0	0	1	0	1	1	1	1	1	1	1	1	1	12
	G	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	11
90	B	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	13
	G	0	0	1	1	0	1	0	1	0	1	1	1	1	1	1	11
91	B	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	13
	G	0	0	0	1	0	1	1	1	1	1	1	1	1	1	1	11
92	B	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	13
	G	0	0	1	0	1	1	0	1	1	1	1	1	1	1	1	11
93	B	0	1	0	1	1	1	1	1	1	1	1	1	0	1	1	13
	G	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	12
94	B	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	13
	G	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1	12
95	B	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	13
	G	1	0	1	1	0	1	1	1	0	1	1	1	1	1	1	12
96	B	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	13
	G	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1	12

S. No.	Sex	I 16	I 5	I 8	I 14	I 12	I 10	I 13	I 6	I 15	I 4	I 3	I 11	I 7	I 9	1 2	Total
97	B	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	14
	G	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	12
98	B	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	14
	G	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	12
99	B	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	14
	G	0	1	1	1	0	0	1	1	1	1	1	1	1	1	1	12
100	B	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	14
	G	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	13

IV

PRESENTATION, ANALYSIS AND
INTERPRETATION OF DATA

C H A P T E R   IV

PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA.

INTRODUCTION

The administration and scoring of test was done according to procedure which is described in previous chapter. The data have been taken from five schools, Mayo College, St. Anselm's Hr. Sec. school, Sophia Girls Hr.Sec.school, St.Mary's Hr.Sec.school, D.M.S. Ajmer. The data were collected in respect of 200 students(100 boys and 100 girls) on fifteen binary operations alongwith academic achievement. Raw scores of all variable of each students are presented in the Appendix.

Raw scores were analysed and interpreted from different angles in order to obtain inherent facts and meaning. The binary operations based on logical thinking were scored out as mentioned in previous chapter. The scores for Academic Achievement in all subjects were collected from their respective schools register record.
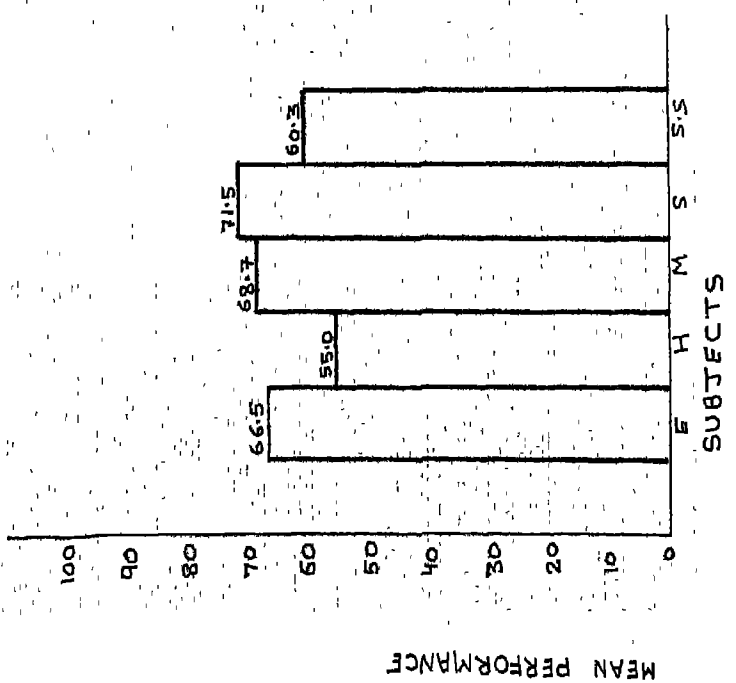
GRAPH No.1

MEAN PERFORMANCE OF ACADEMIC ACHIEVEMENT ON TOTAL SAMPLE:

E=English
H=Hindi
M=Mathematics
S=Science
SS=Social Science

MEAN PERFORMANCE

100 — 90 — 80 — 70 — 60 — 50 — 40 — 30 — 20 — 10 — 0

E 66.5   H 55.0   M 68.7   S 71.5   S.S 60.3

SUBJECTS

The results of different statistic employed in terms
of mean, standard Deviation (S.D.) correlation and 't'
values for all are presented in the tabular form.

Table 6

Mean and Standard Deviation for Academic achievement
of Adolescents.

| Subjects	Mean	S.D.
Achievement in English	66.48	12.64
Achievement in Hindi	55.09	10.49
Achievement in Maths	68.67	16.33
Achievement in Science	71.55	10.89
Achievement in Social Science	60.35	13.32

The results presented in table 6 shows the
value of mean and standard deviation (S.D.) for the
measure of Academic Achievement.

The value of mean in English is 66.48 and value
of S.D. was found to be 12.64

The value of mean and S.D. in the measure of
achievement in Hindi was found to be 55.09 and 10.49
respectively.

GRAPH No. 3

MEAN PERFORMANCE OF FIFTEEN BINARY OPERATIONS.
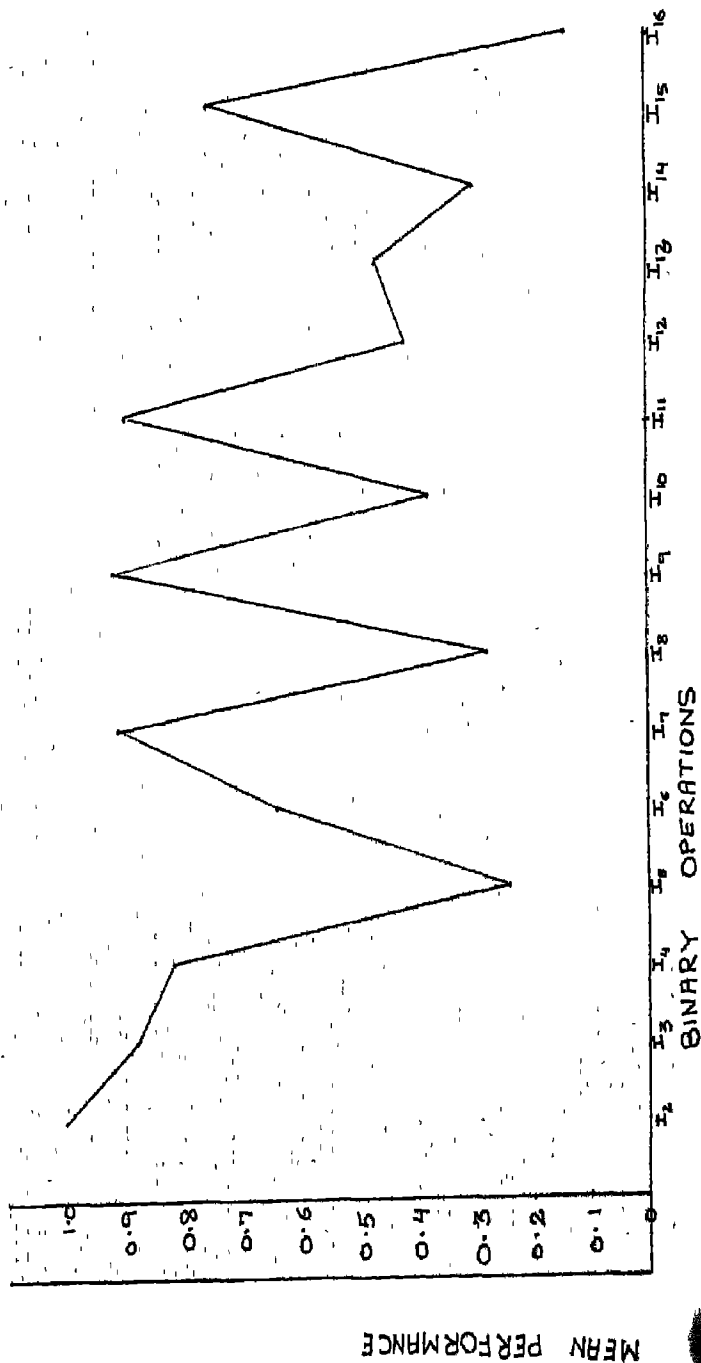
The results of achievement in Maths showed, the value of mean 68.67 and the value of S.D. was found to be 16.33

The value of mean and S.D. is the measure of achievement in Science was found to be 71.55 and 10.89 respectively.

The value of mean and S.D. in Social science was found to be 60.35 and 13.32.

Table 7

The values of Mean and Standard Deviation for Fifteen Binary Operations and Total Adolescent Thought of the total sample.

Binary operations	Mean	S.D.
I_2	1.00	0.0
I_3	0.88	.23
I_4	0.82	0.32
I_5	0.24	0.41
I_6	0.64	0.48
I_7	0.91	0.26
I_8	0.28	0.39
I_9	0.92	0.22
I_{10}	0.38	0.48
I_{11}	0.90	0.22
I_{12}	0.42	0.45
I_{13}	0.47	0.46

Binary operations	Mean	S.D.
I_{14}	0.30	0.46
I_{15}	0.76	0.39
I_{16}	0.14	0.28
I_T	9.18	5.07

Table 7 shows the value of Mean, and standard deviation for fifteen binary operations and total adolescent thought of the total sample.

It is evident from the statistics presented in Table-7 that, the values of mean varies between 0.14 and 1.00, being lowest in I_{16} and highest in I_2.

The values of S.D. for the measure of adolescent thought varies from 0.00 to 0.48 being lowest in I_2 and highest in I_6 and I_{10}.

The mean and S.D. values for total adolescent thought was found to be 9.18 and 5.07 respectively.

Table 8

The values of Mean and Standard Deviation for fifteen Binary Operations and total adolescent thought at different sex levels as well as for the combined Group (N=200).

Binary opera-tions	Sex	Mean	Standard Deviation
I_2	B	1	0
	G	0.79	0.27

GRAPH NO. 3

COMPARISON OF PERFORMANCES OF BOYS AND GIRLS ON DIFFERENT BINARY OPERATIONS

Boys
Girls

MEAN-PERFORMANCE

BINARY - OPERATIONS

Binary operations	Sex	Mean	Standard Deviation
I_3	B	0.95	0.10
	G	0.81	0.34
I_4	B	0.89	0.21
	G	0.63	0.44
I_5	B	0.20	0.41
	G	0.26	0.43
I_6	B	0.57	0.47
	G	0.62	0.47
I_7	B	0.91	0.29
	G	0.79	0.27
I_8	B	0.23	0.43
	G	0.23	0.38
I_9	B	0.95	0.13
	G	0.81	0.28
I_{10}	B	0.34	0.46
	G	0.40	0.48
I_{11}	B	0.89	0.20
	G	0.79	0.27
I_{12}	B	0.31	0.45
	G	0.38	0.47
I_{13}	B	0.60	0.48
	G	0.25	0.45
I_{14}	B	0.26	0.47
	G	0.26	0.42

Binary operations	Sex	Mean	Standard Deviation
I_{15}	B	0.78	0.37
	G	0.67	0.40
I_{16}	B	0.12	0.31
	G	0.11	0.24
I_T	B	8.80	4.07
	G	7.97	6.47

Table 8 reveals that the values of mean and standard deviation for fifteen binary operations and total adolescent though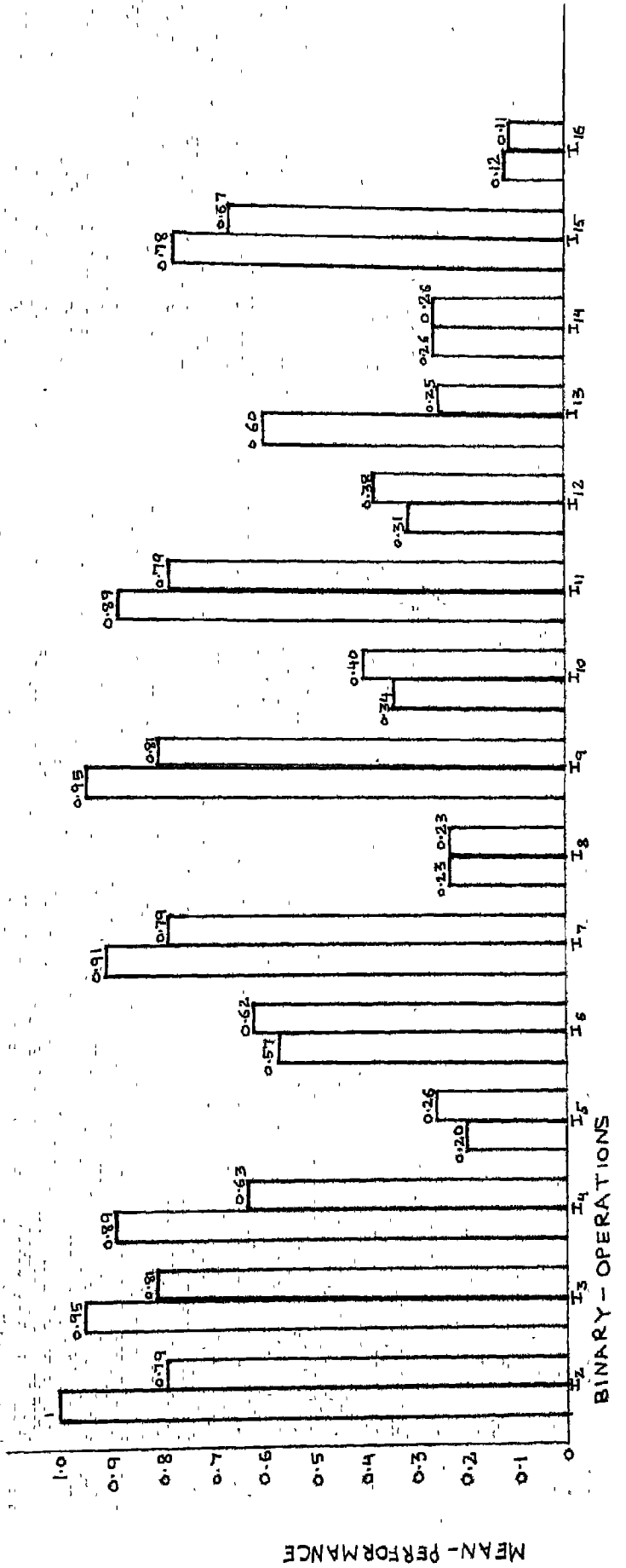t at different sex levels as well as for the combined group. The table has following characteristics. The mean performance of boys on binary operations were better than girls except for I_7, I_0, and I_{12}.

The values of standard deviation were maximum with respect to girls as compared to boys on total adolescent thought.

The mean performance of girls on total auolescent thought was found to be better than boys.

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CHAPTER V

RESULTS OF STATISTICAL ANALYSIS DISCUSSION AND CONCLUSIONS

C H A P T E R   V

RESULTS OF STATISTICAL ANALYSIS, DISCUSSIONS AND CONCLUSIONS

INTRODUCTION

In the previous chapter the responses on the Binary operations and academic achievement has been presented. The Descriptive statistics like mean and S.D. were calculated analysed and interpreted. In the present chapter the results of inferential statistics like 't' value, correlation are presented and interpreted. In this chapter the analysis of the data in relation to the corresponding null hypothesis have been presented in the following paragraphs.

RESULTS BASED ON 't' TEST AND CORRELATION

To test the hypothesis, the data regarding the performance on binary operations and achievement were put to 't' test and correlation to determine the

significance of the differences between them. The 't'
ratios, this calculated for all the fifteen binary
operations, and total adolescent thought have been
presented in tables, and correlation between the
total adolescent thought and other variables.

FIRST NULL HYPOTHESES

There is no sexwise significant difference on
the scores of fifteen binary operations and total
adolescent thought, as well as for the combined groups.

The 't' values were calculated for fifteen
binary operations between the boys and girls to test
the first hypothesis. The results are presented in
the Table No.9.

Table 9

't' ratios regarding the comparative performance of
students on fifteen binary operations and total
adolescent thought at different sex levels as
well as for the combined group.

Binary operations	Sex	Number of students	Mean	S.D.	't'	Level of significar -ce.
I_2	B	100	1.00	0.00	7.77	.01
	G	100	0.79	0.027		
I_3	B	100	0.95	0.10	4.66	.01
	G	100	0.81	0.34		
I_4	B	100	0.89	0.21	5.20	.01
	G	100	0.63	0.44		
I_5	B	100	0.20	0.41	1.00	N.S.
	G	100	0.26	0.43		
I_6	B	100	0.57	0.47	0.71	N.S.
	G	100	0.62	0.47		

Binary operations	Sex	Number of Students	Mean	S.D.	't'	Level of significa -nce
I_7	B	100	0.91	0.29	3.00	.01
	G	100	0.79	0.27		
I_8	B	100	0.23	0.43	0.00	N.S.
	G	100	0.23	0.38		
I_9	B	100	0.95	0.13	4.66	.01
	G	100	0.81	0.28		
I_{10}	B	100	0.34	0.46	1.00	N.S.
	G	100	0.40	0.48		
I_{11}	B	100	0.89	0.20	3.33	.01
	G	100	0.79	0.27		
I_{12}	B	100	0.31	0.45	1.16	N.S.
	G	100	0.38	0.47		
I_{13}	B	100	0.60	0.48	6.15	.01
	G	100	0.25	0.45		
I_{14}	B	100	0.26	0.47	0	N.S.
	G	100	0.26	0.42		
I_{15}	B	100	0.78	0.37	2.20	.05
	G	100	0.67	0.40		
I_{16}	B	100	0.12	0.31	0.27	N.S.
	G	100	0.11	0.24		
I_T	B	100	8.80	4.07	0.54	N.S.
	G	100	7.97	6.47		

Table 9 reveals the 't' ratios regarding the comparative performance of students on fift en binary operations and total adolescent thought at different sex levels as well as for the combined group.

1) From the mean performance of boys and girls we can safely say that in 60% cases the boys were better than girls and in 33.33 percent cases girls were better

than girls and 33.33 percent cases girls werebetter
than boys. In 13.33 percent cases the performance
of boys and girls were equal.

2)   Out of 15 't' ratios $I_2, I_3, I_4, I_7, I_9, I_{11}$
and I_{14} were significant at 0.01 level, and I_{15} was
significant at 0.05 level. $I_5, I_6, I_8, I_{10}, I_{12}, I_{14}$
and I_{16} were not significant at .05 and .01 level.

Thus it has been concluded that out of 15
't' ratios computed 8 't' ratios were found to be
significant between the sexes on Piaget type items.

The null hypothesis first is partially
rejected.

Table 10

Correlation between fifteen binary operations and
academic achievement N=200

S.No.	Correlation between Variables	Correlation coefficient	Level of significance.
1.	Total adolescent thought and achievement in English of total sample	0.18	0.05
2.	Total adolescent thought and achievement in Hindi of total sample	0.03	N.S.
3.	Total adolescent thought and achievement in Maths of total sample	0.26	0.01
4.	Total adolescent thought and achievement in Science of total sample	0.35	0.01

S.No.	Correlation between variables	Correlation coefficient	Level of signifi-cance.
5.	Total adolescent thought and achievement in Social Science of total sample	0.43	0.01
6.	Total adolescent thought and academic achievement of total sample	0.39	0.01

SECOND NULL HYPOTHESIS:

There is no significant correlations between fifteen binary operations and total achievement in English, Hindi, Maths, Science and Social Science of total sample.

For testing the hypothesis number fifth correlation coefficient of the scores on total adolescent thought with English, Hindi, Maths, Science and Social Science were calculated for the total sample. The results are presented in the table No.10.

The result shows that there is significant correlation between the scores on total adolescent thought and achievement in English, Maths, Science, and Social Science of total sample.

There is no significant correlation in Total adolescent thought and achievement in Hindi of total sample.

Thus, the hypothesis Second is partially rejected.

COMPARATIVE PERFORMANCE (IN PERCENTAGE) OF DIFFERENT
OF DIFFERENT BINARY OPERATIONS

PERFORMANCE IN PERCENTAGE

100
90
80
70
60
50
40
30
20
10
0

I_2 9%
I_3 21%
I_4 21.5%
I_5 28%
I_6 34.5%
I_7 38%
I_8 45%
I_9 66%
I_{10} 77.5%
I_{11} 82%
I_{12} 88.5%
I_{13} 90%
I_{14} 91.5%
I_{15} 93%
I_{16} 99.5%

BINARY OPERATIONS

Table 11

Comparative performance (in percentage) of
students in fifteen binary operations in desending
order.

Binary operations	Total	Percentage
I_{16}	18	9
I_5	42	21
I_8	43	21.50
I_{14}	56	28
I_{12}	63	31.50
I_{10}	76	38
I_{13}	90	45
I_6	132	66
I_{15}	155	77.50
I_4	164	82
I_3	177	88.50
I_{11}	180	90
I_7	183	91.50
I_9	186	93
I_2	199	99.50

THIRD NULL HYPOTHESES

There is a hierarchy among the fifteen binary
operations of propositional logic such that certain
operations are prequisite to subsequent operations.

Table 11 reveals the comparative performance

(in percentage) of students on fifteen binary operations in decending order.

Only two items at S.Nos. T_{16} and T_5 have proved to be too difficult for the XI grade pupils.

By seeing the percentage obtained for each operation it can safely be said that these operations (from I_2 to I_{16}) are not found to be in a logical order. Maximum percentage was obtained for operation I_2, this may due to -

(i)   some hints may be given in the question.

(ii)   It's language is easy to understand. Minimum percentage was obtained for operation I_{16} this may be due to :

(i) Hints may not be given in the question

(ii) It's language is difficult to understand.

By seeing these two operations it can be concluded that there is a hierarchy among the fifteen binary operations. But for other binary operations such a hierarchy was not found.

The most visually outstanding pattern in all is that the single set propositions appear logically prerequisite to the double set operations, and further, the double set operations appear as prerequisites to the triple set operations.

Thus, the hypothesis third is not retained.

INTERPRETATION AND DISCUSSION

The aim of this chapter is at exploring the relationship of combinatorial reasoning with the variables of sex and achievement.

The sex difference in the performance of fifteen binary operations showed that the performance of boys were better than girls, as well as for the combined group.

The performance of boys for combinatorial reasoning is much better than the girls for all age levels as well as for the combined group. It can safely be concluded that combination power is much better in boys than the girls.

There was significant correlation (0.01) of total adolescent thought with Maths, Science, Social-Science and with overall academic achievement of the total sample. The correlation of total adolescent thought with English was found to be significant at (0.05) level. It can be concluded that Hindi as a discipline is not helpful in the development of combination reasoning. The linguistic ability like Hindi and English are not or less correlated with

combination reasoning. English is correlated only
at .05 level and Hindi is not correlated at all while
other subjects like Maths, Science and Social science
are significantly correlated with combination reasoning.
It can be interpreted that linguistic abilities are
not helpful in the development of combination reasoning.
The achievement has also shown the significant
correlation (0.01) with the total adolescent thought.

The performance on achievement of boys were
better than girls.

The most visually outstanding point is that
the single-set propositions appear logically prerequisite
to the double-set operations, and further, the double
set operations appear as pre-requisites to the triple-
set operations.

* * *

CHAPTER VI

SUMMARY, EDUCATIONAL IMPLICATIONS

AND PROBLEMS

FOR FURTHER RESEARCH.

C H A P T E R   VI

SUMMARY, EDUCATIONAL IMPLICATION AND PROBLEMS FOR FURTHER RESEARCH.

INTRODUCTION

In the past twenty years, man has brought about a revolution in almost every sphere of existence, by means of new materials, technology and concepts. At the same time philosophers, and psychologists have tried to study and explain human behaviour and human mind. The scientific investigation of thinking processes is gaining importance as the growth of highly logical mind has become the most important goal of the psychology in the developing society. Unlike it, the essence of technology is the designing of new and novel products.

The late Prof. Jean Piaget (1896-1980) had contributed extensively in the field of psychology and to the models of human thinking. Piaget's model suggests qualitative differences in thinking for

each developmental stage.(The basic concepts of
stage theory is the motion of sequential change rather
than age specification) Piaget has grouped these
qualitative changes in thinking into four stages
of development. These are : Sensory Motor (birth to
2 years), Pre-operational (2 to 7 years), Concrete
Operational (7 to 11 years), and Formal Operational
(11 to 15 years). Recently he has hinted at the possibility
of the fifth stage, which covers the period from
15 to 20 years. The first is of little educational
significance, but at the same time, is at the bottom
of all the succeeding stages. In the second stage,
the thinking or reasoning is transductive, that is,
from particular to particular. At the third stage,
reality dominates thinking which is reversed at the
fourth stage. Here, the adolescent pupil can set
up all sorts of hypotheses, test is varied contexts
and various elements of scientific methods. Piaget
believes that the adolescent mind can be described
as a logical computing machine that manipulates
abstract structures. He argues that logical structures
make up the ideal patterns for all living system.
Development of logical thinking among adolescence
is more important to help them to abstracting,
analyzing, generalizing, comparing, defining,
estimating, understanding etc.

The purpose of the present study is to investigate the growth of combinatorial reasoning of science adolescent pupils through sixteen binary operations and its relationship with the variables of sex and achievement.

OBJECTIVES OF THE STUDY

The objectives of the present study are as follows :

(1)   To investigate the effect of sex on the performance of fifteen binary operations (first operation is taken as an example), achievement in different subjects and total adolescent thought.

(2)   To point out the main educational implications arising out of the present study.

(3)   To determine the effect of sex on Hindi, English, Science, Maths and Social Science and Total achievement.

(4)   To find out the relationship between combinatorial reasoning and achievement in English, Hindi, Maths,Science and Social science.

HYPOTHESES

(1)   There is no sex-wise significant difference on the scores of fifteen binary operations and total adolescent thought, as well as for

the combined groups.

(2)   There is no significant correlation between
fifteen binary operations and total achievement
in English, Hindi, Maths, Science and Social-
Science of total sample.

(3)   There is a hierarchy among the fifteen binary
operations of propositional logic such that
certain operations are prerequisite to subsequent
operations.

SELECTION OF THE SAMPLE

Initially a sample of about 300 students (150
boys and 150 girls) was drawn randomly from the
students of five higher secondary English medium schools,
studying in grade XI.

TOOLS USED

A combinatorial reasoning using sixteen binary
operations during adolescence is selected in the
present study. The frame of the test is given below :

S.No.	Statement
1.	Raju and I robbed the bank together.
2.	I robbed the bank on my own.
3.	I am certain Raju did not rob the bank
4.	I robbed the bank but I am not saying whether Raju robbed the bank with me.

S.No.	Statement
5	at least one of us robbed the bank.
6	I certainly did not rob the bank.
7	I am sure that Raju robbed the bank.
8	We could not have robbed the bank together.
9	Neither of us robbed the bank.
10.	Only one of us robbed the bank.
11.	Raju robbed the bank of his own.
12.	If we did rob the bank, we did it together.
13.	If Raju did not rob the bank, I robbed it.
14.	If I robbed the bank, Raju robbed the bank.
15.	If I did not rob the bank, Raju did not rob it.
16.	If I did rob the bank, Raju did not rob it.

STATISTICAL TREATMENT OF DATA

The statistical techniques used in the analysis of data are given below :

1. The value of mean and standard deviation were determined for all the variables.

2. The 't' was employed to find out the significance of difference between mean related to different sub-groups of the variables.

3. Scatter-diagram method of correlation was used for determining the relationship among the variables.

MAJOR FINDINGS

The investigator has arrived at the following-

(1)   The sex difference in the comparative
        performance of boys and girls on total adolescent
        thought as well as for the combined groups
        was found to be different. The performance
        of boys were better than the girls.

(2)   The comparative performance of Achievement
        is favouring boys in comparison to girls.

(3)   The coefficient of correlation between measures
        of achievement with total adolescent thought
        was found to be significant at 0.01 level.
        Thus it can be concluded that as achievement
        increases adolescent thought also increases,

(4)   The boys are better than girls in combinatorial
        reasoning (logical thinking).

(5)   The single set propositions appear logically
        prerequisite to the double set operations,
        and further, the double set operations appear
        as prerequisites to the triple set operations.

EDUCATIONAL IMPLICATIONS AND FURTHER RESEARCH

The educational implications arising out of
Piaget's work are yet at the conjectural stage within
the context of this study, it can be safely said

that children should be trained in carrying out the processes of thought rather than products of thought and that too gradually.

Before this happens, it is also necessary to determine the incidence of formal thought during adolescence among different populations of school going students using the four card problem once this is done, it is more difficult to study this variable in its widest variation in relation to other outside variables like intelligence, personality traits socio-economic status and other school subjects.

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APPENDICES

"Billu And Raju" Answer Sheet

Name :   Age -

Statement	Card No.	Symbolic description of correct Cards
1. Raju and I robbed the bank together.		
2. I robbed the bank on my own.		
3. I am certain Raju did not rob the bank.		
4. I robbed the bank but I am not saying whether Raju robbed the bank with me.		
5. At least one of us robbed the bank.		
6. I certainly did not rob the bank.		
7. I am sure that Raju robbed the bank.		
8. We could not have robbed the bank together.		
9. Neither of us robbed the bank.		
10. Only one of us robbed the bank.		
11. Raju robbed the bank of his own.		
12. If we did rob the bank, we did it together.		
13. If Raju did not rob the bank, I robbed it.		
14. If I robbed the bank, Raju robbed the bank.		
15. If I did not rob the bank, Raju did not rob it.		
16. If I did rob the bank, Raju did not rob it.		

Billu

Raju

CARD I

Yes, I did rob the bank

Yes, I did rob the bank

Billy

Raju

CARD II

Yes, I did rob the bank
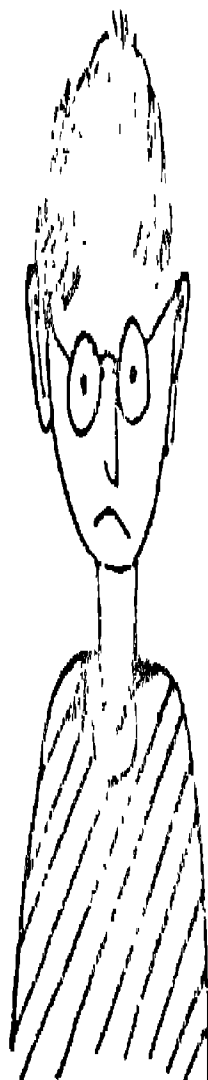
No, I did not rob the bank

Billu

Raju

CARD II

No, I did not rob the bank

Yes, I did rob the bank

Gillu.

Raju

CARD IV

No, I did not rob the bank

No, I did not rob the bank

Scores of Grade XI Science Boys

S.No.	Academic Achievement					Total Achieve-ment
	English	Hindi	Maths	Science	Social Science	
1.	66	54	72	82	75	349
2	58	37	85	80	67	327
3	69	35	68	73	75	320
4	60	68	82	87	69	366
5	55	42	93	75	61	326
6	74	46	78	82	71	351
7	65	59	54	80	66	324
8	64	58	69	77	68	336
9	75	60	68	79	79	361
10	58	52	73	81	60	324
11	63	76	73	85	63	360
12	56	42	65	70	63	296
13	67	33	73	73	67	313
14	69	49	64	77	70	329
15	57	63	56	56	68	300
16	73	47	79	82	78	359
17	54	37	92	71	55	309
18	53	38	91	90	74	346
19	75	70	81	88	61	375
20	60	33	81	78	60	312
21	69	57	97	86	77	387
22	71	56	91	80	81	379
23	64	65	81	84	66	360
24	77	49	79	88	67	360
25	82	47	75	85	66	355

S.No.	Academic Achievement					Total Achievement
	English	Hindi	Maths	Science	Social Sc.	
26	68	67	95	94	71	395
27	72	47	84	80	65	348
28	75	43	77	65	64	324
29	67	72	78	86	71	384
30	84	47	68	84	71	354
31	76	40	83	79	65	343
32	73	57	82	77	74	363
33	66	42	81	71	66	326
34	62	62	75	73	63	335
35	69	47	60	82	69	327
36	71	58	50	78	75	332
37	61	66	85	90	79	381
38	54	57	80	81	66	338
39	83	76	50	74	67	330
40	70	66	82	74	74	366
41	69	61	41	76	68	315
42	62	62	81	83	66	354
43	71	66	75	84	77	373
44	57	73	75	82	75	362
45	49	57	50	52	62	270
46	57	55	38	65	65	280
47	53	55	60	64	59	291
48	62	69	62	76	67	336
49	60	67	47	65	69	318
50	62	68	75	78	58	341

S.No.	Academic Achievement					Total Achievement
	English	Hindi	Maths	Science	Social Science	
51	73	65	81	82	75	376
52	69	60	35	67	67	298
53	68	63	58	56	58	303
54	58	58	40	64	66	286
55	77	83	98	92	70	420
56	70	75	92	80	71	388
57	64	54	64	62	56	300
58	64	70	62	65	63	324
59	40	45	48	71	58	262
60	52	64	35	64	61	276
61	65	71	45	81	65	327
62	52	62	71	70	68	323
63	56	61	81	74	74	346
64	57	55	95	85	69	361
65	59	58	96	85	74	372
66	75	55	92	89	68	379
67	69	48	75	77	74	343
68	66	67	75	80	71	359
69	53	47	47	75	64	286
70	38	53	49	61	59	260
71	43	48	50	72	65	278
72	56	68	80	79	75	358
73	72	73	98	90	73	406
74	54	52	59	69	68	302
75	65	62	73	83	70	353
76	51	64	70	57	83	375

S.No.	Academic Achievement					Total Achievement
	English	Hindi	Maths	Science	Social Science	
77	54	70	75	83	69	351
78	56	56	95	87	64	358
79	58	38	62	74	72	304
80	45	35	64	69	64	277
81	51	36	81	76	69	312
82	46	43	69	84	73	315
83	43	58	60	56	51	285
84	54	65	68	68	64	319
85	52	41	48	55	60	256
86	41	58	58	64	68	289
87	53	69	84	75	68	349
88	36	58	82	63	60	299
89	55	53	41	61	70	280
90	50	55	82	73	70	330
91	54	58	68	67	65	312
92	40	52	62	62	71	287
93	54	63	68	67	65	317
94	48	58	71	63	49	289
95	71	70	82	90	67	380
96	52	56	48	55	60	272
97	54	61	42	63	65	285
98	44	65	72	79	68	328
99	51	62	84	76	67	340
100	59	65	46	65	71	306

Scores of Grade XI Science Girls

S.No.	Academic Achievement					Total Achievement
	English	Hindi	Maths	Science	Social Science	
1	78	61	76	67	50	332
2	78	59	94	85	74	390
3	68	57	52	55	36	268
4	67	47	56	55	36	261
5	78	50	72	59	36	295
6	69	43	54	53	40	259
7	73	53	74	74	74	348
8	66	49	72	87	58	332
9	77	50	44	78	66	315
10	71	51	72	55	40	289
11	65	54	54	56	42	271
12	63	46	80	62	36	287
13	61	34	60	60	36	251
14	72	57	60	63	58	310
15	78	57	76	68	50	329
16	67	55	58	73	72	325
17	72	45	54	67	48	286
18	74	54	72	71	60	331
19	80	58	82	77	70	367
20	78	45	62	70	68	323
21	79	57	48	64	56	304
22	77	58	90	80	68	373
23	71	40	50	58	40	259
24	77	50	66	68	56	317
25	83	57	54	74	70	338

S.No.	Academic Achievement					
	English	Hindi	Maths	Science	Social Science	A. me..
26	80	51	58	65	54	308
27	74	54	74	65	48	315
28	78	43	66	65	58	310
29	76	52	68	74	74	344
30	72	51	70	73	68	334
31	72	50	76	73	52	323
32	72	51	66	66	48	303
33	81	48	72	67	48	316
34	77	55	80	78	80	370
35	85	53	79	77	76	370
36	82	50	74	71	56	333
37	75	48	54	58	46	281
38	71	50	88	90	74	373
39	88	59	92	80	84	403
40	85	65	54	88	88	380
41	75	52	80	69	60	336
42	78	56	94	82	70	380
43	83	53	80	69	52	337
44	80	68	92	88	62	390
45	88	77	88	89	60	402
46	72	58	74	72	40	306
47	76	68	78	80	48	350
48	84	71	84	86	48	373
49	84	74	88	86	50	382
50	72	51	70	67	36	296

S.No.	Academic Achievement					Total Achievement
	English	Hindi	Maths	Science	SocialSc.	
51	72	61	70	72	48	323
52	75	57	72	70	40	314
53	70	44	56	61	36	267
54	75	71	88	76	52	362
55	77	61	76	73	44	331
56	71	63	72	68	36	310
57	70	55	50	51	36	262
58	78	57	58	61	56	310
59	84	69	88	84	70	395
60	80	70	82	83	56	371
61	74	63	84	69	36	326
62	75	62	60	56	36	289
63	74	47	76	67	42	306
64	74	48	58	64	38	282
65	85	65	76	77	50	353
66	75	53	78	71	50	327
67	72	55	70	63	36	296
68	85	55	70	69	46	325
69	73	62	74	67	50	326
70	83	71	88	86	66	394
71	76	63	72	68	36	315
72	75	53	56	66	46	296
73	76	58	78	81	52	345
74	77	47	46	59	38	267
75	80	60	80	76	36	332

S.No.	Academic Achievement					Total Achieve ment
	English	Hindi	Maths	Science	Social Sc.	
76	52	60	48	63	63	286
77	57	60	60	62	65	304
78	50	66	90	77	67	350
79	68	60	80	84	81	374
80	61	44	36	63	64	268
81	64	58	69	77	68	336
82	47	36	36	48	39	206
83	63	54	36	52	47	252
84	54	41	86	64	63	308
85	43	36	82	70	66	297
86	64	36	36	45	52	243
87	59	37	36	60	50	242
88	51	36	62	63	53	264
89	50	62	71	59	47	289
90	68	46	61	52	67	294
91	55	36	36	48	45	220
92	69	36	68	73	75	322
93	61	57	77	75	61	331
94	75	39	71	63	58	306
95	73	44	52	57	51	277
96	60	36	81	78	60	315
97	51	36	62	63	53	264
98	69	50	39	57	77	292
99	65	59	54	80	66	324
100	64	50	66	71	63	313